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UNITED STATES GOVERNMENT MASTER SPECIFICATION FOR
FLAT GLASS FOR GLAZING PURPOSES

FEDERAL SPECIFICATIONS BOARD SPECIFICATION No. 123

This specification was officially adopted by the Federal Specifications Board on April 1, 1924, for the use of the Departments and Independent Establishments of the Government in the purchase of flat glass for glazing purposes.¹

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¹ The need for a master specification for glass for glazing was regarded by the Federal Specifications Board as sufficiently urgent to justify an exhaustive study of the subject and the preparation of suitable specifications. This work was originally undertaken by the Bureau of Standards through conferences with official representatives of the various manufacturing and distributing interests of the glass industry and the consumers, including the Government. The tentative draft was made the basis of the specification finally adopted by the Federal Specifications Board upon recommendation of the technical committee of the board.

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I. CLASSIFICATION OF GLASS FOR GLAZING PURPOSES

For the purpose of this specification there is given below a classification of glass for glazing:

Polished plate glass.....	{	Second silvering quality. Glazing quality.
Clear window glass.....	{	Single strength..... { A quality. B quality.
	{	Double strength..... { A quality. B quality.
	{	Heavy Sheet..... { Glazing quality. Factory-run quality.
Processed glass.....	{	Chipped..... { No. 1 processed. No. 2 processed.
	{	Ground..... { Acid ground. Sand blasted.
Rolled figured sheet.....	{	Figured sheet..... { Large variety of patterns.
	{	Colored figured sheet.
Wire glass.....	{	Polished wire.
	{	Polished (one side).
	{	Figured.
Ornamental.....	{	Corrugated.
	{	Colored.
Prism glass.....	{	Figured plate (polished one side).
	{	Pressed tile.
	{	Rolled sheet.
	{	Rolled and pressed sheet.

II. DEFINITIONS OF THE GENERAL CLASSES OF PLATE, CLEAR WINDOW, AND ROLLED SHEET GLASS

PLATE GLASS.—Transparent, flat, relatively thin glass having plane polished surfaces and showing no distortion of vision when viewing objects through it at any angle. Plate glass is made at present by casting and rolling large sheets periodically or by rolling a continuous sheet. The sheets are then ground and polished.

CLEAR WINDOW GLASS.—Transparent, relatively thin, flat glass having glossy, fire finished, apparently plane and smooth surfaces, but having a characteristic waviness of surface which is visible when viewed at an acute angle or in reflected light. Clear window glass is made at present by hand blowing or by machine blowing and drawing into cylinders and flattening, or by drawing directly into a sheet, the surface finish being that obtained during the drawing process.

PROCESSED GLASS.—There are three kinds of processed glass either in plate or window glass, viz, ground glass, chipped one process, and chipped two processes. The ground glass is made by either sand blasting or acid etching of one surface. The chipped glass is made by applying either one or two coatings of glue to the ground surface.

ROLLED FIGURED GLASS.—A flat glass in which the vision is more or less obscured either by the roughened surface produced in rolling or by the impression of a large variety of decorative designs on one surface of the sheet.

WIRE GLASS.—Rolled flat glass having a layer of meshed wire incorporated approximately in the center of the sheet. This glass is produced with polished or figured surfaces.

ORNAMENTAL PLATE.—A figured plate glass made by rolling or rolling and pressing and having the plane surface ground and polished.

PRISM GLASS.—A flat glass having prism shaped parallel ribs designed for deflecting light. This is made as a rolled plate or as a pressed plate, of which one side may be ground and polished, or as a pressed tile.

III. GENERAL PRINCIPLES

All flat glass contains some imperfections, and the principle employed in grading is to exclude all defects that would be objectionable in a given grade. This is difficult to do, since there are no sharp lines of demarcation between grades, and experienced inspectors will differ in judgment as the quality of the glass approaches the limits of the grades. Small lights must be quite free from imperfections as compared with larger ones, and the center of any sheet should be clear, whereas the edges may contain more pronounced defects.

I. METHOD OF EXAMINATION

The method of examination is described in these specifications in order to make the results more uniform and defines the condition under which glass should be examined, because the distance from the glass, the angle between the glass and the line of sight, and the intensity of light all affect the visibility of imperfections. These specifications should be interpreted by examining the glass in the following manner, with reference to the definitions of defects listed in the glossary.

The glass should be examined when placed in a position similar to that of a glazed light with the observer's eye on a level with the center of the sheet and looking through the glass from a distance of about 36 inches into the light from a clear sky without any sun or any close background.

The visibility of waves, lines, or cords depends chiefly upon the angle of observation, and the intensity of these defects can be classified on this basis. The values given for angles are the angles the line of sight makes with the sheet of glass when in a vertical position. Slight movement of the head horizontally through an angle of 2° or 3° will make waves or lines more perceptible.

2. ACCEPTANCE OR REJECTION

Acceptance or rejection of a shipment or delivery shall be based on an examination of the following quantities: For orders of 100 lights or less, all shall be examined; for orders of 101 to 500 lights, at least 50 per cent shall be examined; for orders of 501 or more lights, at least 25 per cent shall be examined. Boxes shall be selected from the shipment at random.

If not more than 10 per cent of the lights examined are below quality, the shipment shall be accepted, provided the lights below the specified grade are not distinctly below the upper limit of the next lower grade. If, however, an entire shipment of 500 lights or more is examined, not more than 5 per cent may be below quality.

IV. SPECIFICATION FOR POLISHED PLATE GLASS

1. GENERAL REQUIREMENTS

SIZES AND THICKNESS.—The standard thicknesses of plate glass shall be $\frac{1}{8}$, $\frac{3}{16}$, $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, 1, $1\frac{1}{4}$, and $1\frac{1}{2}$ inches. Sheets are available $\frac{1}{4}$ inch thick in sizes having a maximum area of 250 square feet. Glass of $\frac{1}{4}$ inch thickness may be furnished having almost any desired dimension under the following maximums: 120 by 280 inches, 144 by 260 inches, 160 by 240 inches. The standard stock thickness for glazing purposes is $\frac{1}{4}$ inch, but this may vary between $\frac{7}{32}$ and $\frac{5}{16}$ inch, although $\frac{1}{8}$ and $\frac{3}{16}$ inch glass are carried in stock in the larger cities.

TOLERANCES IN THICKNESS.—The maximum and minimum thicknesses allowed shall not be more than the given thickness plus or minus one-half the difference between the standard thicknesses, although for $\frac{1}{4}$ -inch glass occasional plates as thick as $\frac{5}{16}$ inch are supplied. The general variation in thickness should not be more than $\frac{1}{32}$ inch for individual lights under 10 square feet in thicknesses up to $\frac{1}{4}$ inch. The variation in lights over $\frac{1}{4}$ inch in thickness should not exceed one-half the total tolerance for that thickness.

TOLERANCES IN DIMENSIONS.—Variation from dimensions ordered shall not be more than $\frac{1}{32}$ inch per $\frac{1}{8}$ inch of thickness.

GRADES.—Plate glass shall be furnished for glazing purposes in one of two grades as specified. These grades will be known as second

silvering and glazing qualities. Second silvering quality is invariably used where the highest standard of glazing is required and imperfections are discoverable only on close inspection. This quality is rarely sold for glazing purposes in sizes over 20 square feet. Glazing quality represents the usual selection of plate glass supplied when quality is not otherwise definitely specified.

As allowable tolerances in quality must vary considerably with size of sheet required, different specifications will apply in each of the following four divisions according to size. Division I, sheets up to and including 10 square feet in area; Division II, sheets having an area greater than 10 square feet, but not greater than 25 square feet; Division III, sheets having an area greater than 25 square feet, but not greater than 75 square feet; Division IV, sheets having an area greater than 75 square feet.

2. SPECIFIC REQUIREMENTS FOR DIFFERENT SIZES

(a) DIVISION I.—SIZES UP TO AND INCLUDING 10 SQUARE FEET

SECOND SILVERING QUALITY.—This glass shall not contain any major defects. The central area of this glass may contain only well-scattered seeds. Ream, skim, short finish, and scratches which can not be removed by buffing are not permissible. The edges may contain coarse seeds, but none shall be larger than $\frac{1}{32}$ inch in diameter.

GLAZING QUALITY.—The central area of this quality may contain numerous scattered seed, including an occasional coarse seed, but no heavy seed. Small bubbles may occur on the edge. Stones, large bubbles, skim, ream, or long or heavy scratches are not permissible. Faint strings in the corners or upper edge of the light are permissible. The polish shall not show areas of short finish.

(b) DIVISION II.—SIZES FROM 10 TO 25 SQUARE FEET, INCLUSIVE

SECOND SILVERING QUALITY.—The central area of this quality may contain more numerous fine seed than the small sizes and an occasional coarse seed. The edges may contain occasional small bubbles and fine strings. No heavy defects or scratches which can not be removed by buffing are permissible. The polish must be good and free from visible short finish.

GLAZING QUALITY.—The central area may contain small bubbles and fine strings or ream which does not give visible distortion when looking straight through the glass, but no long or heavy scratches. The edges may contain bubbles over $\frac{3}{32}$ inch, visible scratches shorter than 10 inches, small areas of ream, strings, and small stones not larger than $\frac{1}{32}$ inch, but these defects should not be grouped

nor interfere with the vision. The polish over the central area should be good, but patches of light short finish may be present about the edges.

GENERAL.—None of the above grades or sizes may contain any heavy or long lines, streaks of ream, any bubbles larger than $\frac{1}{8}$ inch, visible poor polish, open bubbles, areas of skim, or stones over $\frac{3}{32}$ inch in diameter.

(c) DIVISION III.—SIZES FROM 25 TO 75 SQUARE FEET, INCLUSIVE

GLAZING QUALITY.—Lights of this size may contain numerous visible and larger imperfections not allowed in the smaller lights, but these must not be grouped or so prominent that they noticeably interfere with the vision. The central area of the plate shall be free from these larger defects.

The sheets may contain seed of any size but not heavy seed, except in relatively small patches on the outer border of the sheet, occasional bubbles up to $\frac{1}{8}$ inch in the center and up to $\frac{3}{16}$ inch on the borders, strings, ream, and skim in very limited areas, if not causing a deformation of objects viewed through the plate, occasional scratches and small stones under $\frac{1}{16}$ inch.

Heavy ream, heavy cords, bubbles larger than $\frac{3}{16}$ inch in diameter, stones larger than $\frac{1}{16}$ inch in diameter, large fire cracks, areas of unpolished glass, easily visible poor polish, large open bubbles, or sand holes are not permitted. The large defects should be confined to the upper edge and upper corners of the sheet, the lower and central areas to be relatively free from major defects.

(d) DIVISION IV.—SIZES GREATER THAN 75 SQUARE FEET

Sheets larger than 75 square feet may contain defects of almost any kind, except that they must not show large areas of heavy seed or bubbles nor have any defects which will cause spontaneous breakage, such as skim or large stones ($\frac{1}{8}$ inch diameter), or show any areas of unpolished glass.

V. SPECIFICATION FOR CLEAR WINDOW GLASS

1. GENERAL REQUIREMENTS

Clear window glass for glazing is made in several different qualities and in the varying thicknesses shown in Table 1 below. Single strength and double strength window glass is regularly supplied in two standard qualities, known as A quality and B quality. A limited amount of this glass, known as AA quality, which is especially free from defects, is sometimes selected for special purposes and

may be specified if desired. It must be borne in mind, however, that the total amount of AA glass produced by the manufacturers does not exceed 3 per cent of the total amount of window glass produced.

There is also a limited amount of single strength and double strength glass produced in a quality inferior to B quality and is known as "fourth quality." The amount of glass produced in this quality also represents a very small percentage of the total window glass produced. A quality of single strength glass inferior to "fourth quality" is also produced in very limited quantities and is known as C quality. This is the lowest grade of glass that is packed and marketed in this country.

Window glass is also produced in thicknesses heavier than double strength, and according to its thickness it is classified as (1) 26-ounce glass, (2) 29-ounce glass, (3) 34-ounce glass, (4) 39-ounce, or $\frac{3}{16}$ -inch, glass. Twenty-six and twenty-nine-ounce glass are produced only in A and B qualities; 34-ounce and 39-ounce or $\frac{3}{16}$ -inch glass are produced in glazing and factory-run quality.

TABLE 1.—*Tolerances in thickness and average weight of clear window glass*

Classification	Thickness		Number of lights per inch		Average weight in ounces per square foot
	Minimum	Maximum	Minimum	Maximum	
	<i>Inch</i>	<i>Inch</i>			
Single strength.....	0.080	0.100	10.5	12.0	18.5
Double strength.....	.111	.125	8.0	9.0	24.5
26-ounce glass.....	.125	.135	7.5	8.0	26.0
29-ounce glass.....	.135	.148	6.5	7.0	29.0
34-ounce heavy glass.....	.150	.175	6.0	6.5	34.0
39-ounce heavy glass.....	.176	.205	5.0	5.5	39.0

SIZES OBTAINABLE.—The maximum dimensions recommended are:

Classification	Width	Length
	<i>Inches</i>	<i>Inches</i>
For single strength.....	40	50
For double strength.....	60	80
For heavy sheet.....	66	90

TOLERANCES IN THICKNESS.—Thickness of individual sheets shall not vary more than one-half of the total variation allowed for that particular strength of glass, as shown in Table 1 above, for sizes up to 50 united inches. For larger sizes variations in thickness may be equal to the tolerance allowed for that class.

FLATNESS.—All clear window glass shall be relatively flat. Slight curvature, provided it is regular, will be allowed, but the maximum deformation or bow shall not make an arc higher than 0.5 per cent of the length of the sheet. Reverse curve or crooked glass is not allowable.

GLAZING.—Window glass should always be glazed with the convex side out.

DIMENSIONS.—Glass must be cut to dimensions ordered with an allowable tolerance of $\frac{3}{32}$ inch per $\frac{1}{8}$ inch of thickness.

2. SPECIFIC REQUIREMENTS FOR SINGLE AND DOUBLE STRENGTH GLASS

(a) **A QUALITY.**—The defects permitted in this quality are faint strings or lines, slight burn, small seeds, small blisters, and light scratches. No light shall contain all of these defects, and those present may not be grouped when in the central area of the sheet. Strings, lines, or burn specks shall not be of such intensity that they are visible when observing the sheet at an angle greater than 30° between the line of sight and the glass. Waves shall not be visible at an angle greater than 20° with the glass. Blisters shall not exceed $\frac{1}{4}$ inch in length unless they occur near the edge of the sheet.

In general, the central area of the light shall be practically free from defects, and the appearance of the light as a whole shall be such that there is no perceptible interference with the vision as long as one is not looking through the glass at an acute angle.

(b) **B QUALITY.**—This quality admits of the same kind of defects as A quality, but they may be larger, heavier, and more numerous. Occasional scattered blisters not more than one-half inch long may occur over the central area of the sheet. Larger blisters up to 1 inch in length may occur about the bordering areas.

Waves should not be of such intensity that they are visible when observing the sheet at an angle greater than 45° with the glass unless on the border.

Burn spots may be visible when looking directly through the glass, but they must not cause any appreciable depression, and the speckled appearance must not be so great as to interfere with vision when examining the glass in the specified position.

3. SPECIFIC REQUIREMENTS FOR HEAVY SHEET WINDOW GLASS

(a) **GLAZING QUALITY.**—The same specifications for selecting provided for A quality single strength and double strength glass shall apply.

(b) **FACTORY-RUN QUALITY.**—This quality is the run of glass as produced by the factory. It may contain glass of very good quality and some glass of very ordinary quality. However, the glass that contains heavy cords, lines, or strings over the entire surface, raised blisters, cap strings, stones, or batch particles causing a rough surface or depression, or having its surface covered with heavy burn, wrinkles, deep scratches, or stone shall not be included in this quality.

VI. SPECIFICATION FOR ROLLED FIGURED SHEET GLASS

This type of glass is supplied in but one quality for glazing purposes. It is made in a wide variety of surface finishes which serve to obscure the vision as well as provide a decorative finish and also special patterns for increasing illumination by diffusion or deflection.

Figured sheet glass is made in the following thicknesses: $\frac{1}{8}$, $\frac{3}{16}$, $\frac{1}{4}$, and $\frac{3}{8}$ inch, and can be obtained in sizes up to 48 inches wide and 130 inches long.

VII. SPECIFICATION FOR WIRE GLASS

This type of glass is supplied in but one quality for glazing purposes. It is made polished and in a wide variety of surface finishes which serve to obscure the vision as well as provide a decorative finish and also special patterns for increasing illumination by diffusion or deflection.

Wire glass can be made in the following thicknesses: $\frac{1}{8}$, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$, $\frac{1}{2}$, and $\frac{3}{4}$ inch. The standard type of wire used has a mesh about $1\frac{1}{4}$ by $\frac{7}{8}$ inch and is not lighter than 24 B. & S. gauge, except for $\frac{1}{8}$ inch, in which 26 B. & S. gauge wire is used. Wire glass can be obtained in sizes up to 60 inches wide and 144 inches long.

Corrugated wire glass is made in one thickness, which is about 5/16 inch. Deep angle sheets are 2 1/2 inches C. to C. of corrugations and mesh with corrugated asbestos. Shallow angle sheets are 2 11/16 inches C. to C. and mesh with corrugated iron.

VIII. SPECIFICATION FOR GLASS FOR ABSORBING AND INTERCEPTING ULTRA-VIOLET AND INFRA-RED RAYS

This glass may be made as rolled figured sheet or wire glass in flat or corrugated sheets. It shall be of such composition that not less than 80 per cent of the ultra-violet rays² and not less than 50 per cent of the infra-red rays are excluded.

IX. SPECIFICATION FOR POLISHED FIGURED OR ORNAMENTAL PLATE GLASS

Ornamental plate glass is a figured sheet glass, the smooth surface of which has been polished. It is made $\frac{1}{4}$ inch thick in sizes up to 50 inches wide by 100 inches long and in a variety of patterns. Chipped plate glass, single and double processed, is also sold as polished figured plate glass.

²In order to obtain this value, the ultra-violet transmission, including reflection, should not exceed the following values: At 0.405, Tr.=30 to 40 per cent; at 0.365, Tr.=12 to 15 per cent; and at 0.313, Tr.=0.5 to 1.0 per cent.

X. SPECIFICATION FOR PRISM GLASS

This glass is made as rolled sheet glass with or without wire and as a pressed tile. It is made with one side polished, sold as prism plate glass, or as rough rolled prism glass, and can be furnished in sizes up to 42 inches by 138 inches, 1/4 inch thick, and in sizes between 42 and 60 inches by 138 inches, 5/16 inch thick. The prism ribs are furnished running horizontally with the length of the sheet. Prism wire glass is made in sizes up to 42 by 138 inches, with a thickness of 3/8 inch. Pressed prism tile are made either 4 by 4 inches square or 5 by 5 inches square.

XI. GENERAL SPECIFICATION FOR ROLLED FIGURED SHEET GLASS, WIRE GLASS, ORNAMENTAL PLATE GLASS, AND PRISM GLASS

QUALITY.—The glass shall contain no visible stones which may cause spontaneous breakage of the sheet, no fire cracks or exposed wire. The pattern shall be uniform over the surface without any easily visible blemishes.

TOLERANCE FOR THICKNESS.—The total variation in thickness of this glass shall not be more than 3/64 inch for any single sheet; the maximum variation allowed for any specified thickness may not be greater than 3/64 inch over or under that thickness.

DIMENSIONS.—Glass must be cut to dimensions ordered with an allowable tolerance of 1/32 inch per 1/8 inch of thickness.

XII. GLOSSARY OF TERMS USED IN THESE SPECIFICATIONS

The various terms used in describing imperfections appearing in flat glass are the following: Seeds, boil bubbles, blisters, open bubbles, cords, strings, ream, knots, scratches, light grazes, cullet cuts, sand lash, sleek, short finish, sand holes, feathers, skim, stones, waves, lines, burns, burn spots, and fire cracks.

Many of these terms may be grouped under one general term, and a number are not necessary in preparing specifications, although they are often used in a factory as identifying certain imperfections.

The following terms shall be used in specifications:

Plate glass		Clear window glass	
Seeds.	Open bubbles.	Seeds.	Scratches.
Short finish.	Ream.	Blisters.	Strings.
Skim.	Stones.	Lines.	Cords.
Strings.	Fire cracks.	Burns.	Stones.
Scratches.	Sand holes.		
Bubbles.			

Definitions, causes, and brief description of these various imperfections are given herewith.

BUBBLES.—Gas inclusions in any rolled glass. These inclusions are practically always spherical and brilliant in appearance. The term applies to all such inclusions larger than $1/32$ inch in diameter. The term small bubbles (commonly known as boil) refers to sizes between $1/32$ inch and $3/32$ inch.

SEEDS.—Minute bubbles less than $1/32$ inch in diameter. Fine seeds are visible only on close inspection, usually appearing as small specks and are an inherent defect in the best quality of plate glass. Seed about $1/64$ to $1/32$ inch in diameter are usually considered as coarse seed.

HEAVY SEED.—Refers to a condition when the fine and coarse seed are very numerous, such as 25 or more to the square inch.

SCATTERED SEED.—Indicates a condition of few and occasional easily visible coarse seed. Two or three may be spaced 1 or 2 inches from each other, but one here and there at much greater distances apart is the usual intention of the term.

OPEN BUBBLES.—Bubbles which have been broken into by grinding, leaving a hemispherical hole in the glass surface.

BLISTERS.—Elongated bubbles or seeds, elliptical in shape. This form of bubble is generally peculiar to window glass but may be found in plate glass manufactured by recently improved methods. In both cases the method of manufacture draws out practically all bubbles in one direction.

SKIM.—Streaks of dense seed with accompanying small bubbles.

STRINGS.—Wavy, transparent lines appearing as though a thread of glass had been incorporated into the sheet.

CORDS.—Heavy strings incorporated in the sheet, occurring without any regularity of direction, and appearing to be of considerable thickness rather than on the surface.

REAM.—An area of unhomogeneous glass incorporated in the sheet producing a wavy appearance.

SCRATCHES.—Any marking or tearing of the surface appearing as though it had been done by either a sharp or rough instrument. Scratches occur on sheet glass in all degrees from various accidental causes.

SHORT FINISH.—Insufficient polish or lack of brilliancy; improperly finished surface which has the appearance of being slightly pitted and wavy when the surface is viewed in reflected light. These indentations, which are slight, have a polished rather than a ground surface, but the general effect is a slight dulling of the surface. Poor polish is usually caused by improper grinding.

STONES.—Any opaque or partially melted particle of rock, clay, or batch ingredient imbedded in the glass.

LINES.—Waves which extend continuously across the sheet, so that the reflection from the surface appears as a line or series of lines extending either the full width or a considerable distance across the sheet.

BURNS.—Small projections or indentations on the surface appearing as an area of small specks, together with some destruction of the surface polish. An imperfection occurring during the flattening of window glass caused by flattening furnaces becoming too hot.

FIRE CRACKS.—Small cracks penetrating the surface of the sheet. Usually in the shape of short hooked crescents. Caused by sudden heating or chilling of the surface.

SAND HOLES.—Rough spots on the polished surface produced during coarse grinding, which fine grinding did not later remove owing, to some extent, to coarse grains of grinding sand becoming mixed with finer grades.

CENTRAL AREA OF SHEET.—This term is used with slightly different interpretation with reference to plate or window glass. In plate glass the central area is considered to form an oval or circle centered on the sheet whose axes or diameters do not exceed 80 per cent of the over-all dimension. This allows a fairly large area at the corners, which may have imperfections not allowed in the central area.

In window glass the central area is considered as being a circle having a diameter equal to half the width of the sheet or an ellipse having one diameter equal to half the length of the sheet and the other diameter equal to half the width of the sheet.

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